

1 Claims

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3 1. A method of surveying boreholes, comprising:
4 providing an instrument package in a leading
5 end of a drillstring, said instrument package
6 comprising first and second single-axis sensors
7 mounted for rotation with the drillstring about the
8 rotational axis of the drillstring, the first sensor
9 being an accelerometer and the second sensor being a
10 magnetic fluxgate or a rate gyro;

11 rotating the drillstring;

12 deriving from the first sensor the inclination
13 angle of the drillstring at the instrument package;
14 and

15 deriving from the second sensor the azimuth
16 angle of the drillstring at the instrument package.

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18 2. The method of claim 1, wherein the sensor is
19 radially spaced from the borehole axis and has its
20 sensing axis in a plane containing the borehole axis
21 and an axis perpendicular thereto.

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23 3. The method of claim 1, wherein the sensor is
24 radially spaced from the borehole axis and has its
25 sensing axis in a plane parallel with the borehole
26 axis.

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28 4. The method of claim 1, wherein the drilling
29 control rotation angle is obtained from the sensor
30 outputs.

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1 5. The method of claim 1, wherein the sensor
2 outputs are integrated over the four quadrants of
3 rotation and the desired output angle is derived
4 from the integrated output.

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6 6. The method of claim 1, wherein the instrument
7 package suitably includes rotation angle reference
8 means for use in the integration.

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10 7. The method of claim 1, wherein additional
11 information is derived such as the local
12 gravitational and magnetic field vectors.

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14 8. An apparatus for use in surveying boreholes,
15 the apparatus comprising:

16 an instrument package adapted to be included in
17 the leading end of a drillstring , the instrument
18 package comprising first and second single-axis
19 sensors mounted for rotation with the drillstring
20 about the rotational axis of the drillstring, the
21 first sensor being an accelerometer and the second
22 sensor being a magnetic fluxgate or a rate-gyro; and

23 computing means for deriving from the first
24 sensor while the drillstring is rotating the
25 inclination angle of the drillstring at the
26 instrument package, and for deriving from the second
27 sensor while the drillstring is rotating the azimuth
28 angle of the drillstring at the instrument package.

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30 9. The apparatus of claim 8, wherein the sensor is
31 radially spaced from the borehole axis and has its

1 sensing axis in a plane containing the borehole axis
2 and an axis perpendicular thereto.

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4 10. The apparatus of claim 8, wherein the sensor is
5 radially spaced from the borehole axis and has its
6 sensing axis in a plane parallel with the borehole
7 axis.

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9 11. The apparatus of claim 8, wherein the computing
10 means operates to integrate the sensor outputs over
11 the four quadrants of rotation and to derive the
12 desired output angle from the integrated outputs.

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14 12. The apparatus of claim 8, further comprising
15 rotation reference means for use in the integration.